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"Diffusion and Defect Characterization Studies of Mercury Cadmium Telluride"

Principal Investigator: D. A. Stevenson

Department of Materials Science and Engineering
Stanford University
Stanford, CA 94305

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I. Progress During the Report Period

During the last six month period, progress has continued on the two major areas of this program: diffusion studies in Mercury Cadmium Telluride (MCT); and growth studies in MCT. The diffusion studies have emphasized the question of multiple and distinct Hg profiles in self-diffusion and the Kirkendall effect for interdiffusion. The growth studies have concerned the relation between the surface morphology of epitaxial layers and the substrate orientation, the development of new Hg rich liquid phase epitaxial growth method, and a continuation of an electrochemical determination of thermodynamic properties of MCT and related binary compounds.

A. Diffusion Studies:

Progress continues on the topic of tracer diffusion in MCT. In the present report period, Hg^{203} tracer diffusion has continued in $Hg_{0.8}Cd_{0.2}Te$ (MCT) and extended to include HgTe (MT). Our major objective is to establish the number of branches in the tracer concentration profiles and associate a diffusion mechanism with each branch. This has been a subject of considerable interest and debate in previous studies. Two or three branches are reported by previous authors, however, the experimental conditions are different and comparison is difficult. Hg^{203} diffusion is studied at two different temperatures for both MT and MCT, at 500°C and at 300°C. Three branches appear in Hg^{203} diffusion profile in MCT at 500°C, whereas there are only two branches in MT. We have detected the fastest (third) branch by short time anneals at 500°C; however, we have not yet established this branch at lower temperatures (300°C) in MCT. Cd^{109} diffusion-vapor pressure isotherms have also been studied in MCT. As a result of three profiles up date, it appears that two branches exist for the experimental conditions studied. Interdiffusion of HgTe-CdTe couples is being studied for both Hg-rich and Te-rich conditions at several temperatures (300°C - 600°C) and low temperature interdiffusion studies are in progress (300°C to 400°C). In order to address the important problem of stability of junctions at low temperature, improved spacial resolution of the diffusion profile is being established by an angle lapping method. "Kirkendall effect" and marker experiments are also in progress.

B. GROWTH STUDIES

1) The effect of substrate orientation on surface morphology was investigated for both the Isothermal vapor phase epitaxial (IVPE) and Liquid phase epitaxial (LPE) growth techniques. These experiments were performed using {111} CdTe and CdZnTe (4.5% ZnTe) substrates which were spherically lapped using a simple grinding fixture, the radius of curvature being approximately 8.75 cm. LPE growth was performed on the 'A' (Cd) face and IVPE layers were grown on both the 'A' and 'B' faces. These experiments were based on similar studies in the GaAs system by E. Bauser and H.P. Strunk (J. Crystal Growth, Vol. 69. (1984) pp. 561), which established that the substrate misorientation critically effects the layer surface morphology and surface morphology in turn can have an effect on the segregation of impurities, due to local changes in the segregation coefficient. This experiment using a spherical surface allows us to investigate a continuous range of misorientations during a single experiment. The result of this work indicates that there is a sharp transition in growth mechanism from a presumed dislocation controlled growth process in the region of zero deviation from {111} to one governed by the motion of the more well known terrace-like structures as the deviation from {111} is increased. The surface morphology is far superior in the dislocation controlled regions, with the critical misorientation for the process being 0.2° (plus or minus 0.1°) from {111} for both growth techniques.

2) The theory of Hg solvent isothermal liquid phase epitaxy has been slightly modified. It has been realized that growth is not dependent on there being a discrete 'source'; the saturated melt itself may act as the source. This has been confirmed by experiment. The remainder of the theory remains essentially the same.

3) The thermodynamic investigation of MCT is continuing using a Li electrolyte in an electrochemical cell. Early indications are that there is considerable solubility of Li in the tellurides, on the order of 10's of atomic percent. This work must proceed slowly since long times are needed for the system to obtain equilibrium, 2-4 weeks. This problem can be overcome by using thinner samples and more cells. This work will be the primary focus of attention in the coming 6 month period.

II. Planned Activity for the Coming Report Period

The work planned for the future emphasizes the following topics; constinuation of the tracer diffusion studies in MCT and MT; analysis of interdiffusion results for CT/MT couples; evaluation of IVPE layer properties; and extension of thermodynamic studies using Li electrolyte electrochemical methods.

III. There are no changes in the Key Personnel in the Reporting Period

IV. D.A. Stevenson presented a seminar at Texas Instruments entitled "Diffusion and Growth Studies in Mercury Cadmium Telluride", on December 9, 1985.